Exchange coupling in magnetic semiconductor multilayers and superlattices*

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The study of ferromagnetic (FM) dilute magnetic semiconductors (DMSs) continues to be of great interest because of their potential for spin-electronic device application. While there has been much progress in our understanding of DMS materials - particularly of the canonical III-V system $Ga_{1-x}Mn_xAs$ - many issues still remain unresolved. One of these is the nature of interlayer exchange coupling (IEC) in GaMnAs-based multilayers, an issue that is important from the point of view of possible spin-electronic ("spintronic") applications. Consider, for example, IEC between two magnetic layers separated by a non-magnetic spacer. The ability to manipulate such IEC enables us to control the relative direction of magnetization in one magnetic layer relative to the other, which lies at the heart of giant magnetoresistance (GMR) devices in wide use in information processing. In this connection, in the present case of GaMnAs multilayers it is important to establish under what conditions the IEC between adjacent GaMnAs layers is antiferromagnetic (AF) or ferromagnetic (FM), since manipulation of the IEC can then be directly applied to achieve GMR devices based on this material. In this talk we will describe magneto-transport, magnetization, and neutron reflectometry experiments applied to two types of GaMnAs-based structures - superlattices and tri-layers - consisnting of GaMnAs layers separated by non-magnetic GaAs spacers. These measurements serve to identify conditions under which AFM coupling will occur in such GaMnAs/GaAs multilayer systems, thus providing us the information which can be used for manipulating magnetization (and thus also GMR) in structures based on the ferromagnetic semiconductor GaMnAs.

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